Equinoctial atmospheric activity over Titan dune fiels revealed by Cassini/VIMS

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EQUINOCTIAL ATMOSPHERIC ACTIVITY OVER TITAN DUNE FIELDS REVEALED BY CASSINI/VIMS. S. Rodriguez[1], S. Le Mouélic[2], J.W. Barnes[3], M. Hirtzig[4], P. Rannou[5], C. Sotin[2,6], R.H. Brown[7], J. Bow[3], G. Vixie[3], T. Cornet[2], O. Bourgeois[2], C. Narteau[8], S. Courrech du Pont[9], A. Le Gall[10], E. Reffet[1], C.A. Griffith[7], R. Jaumann[11], K. Stephan[11], B.J. Buratti[6], R.N. Clark[12], K.H. Baines[13], P.D. Nicholson[14], A. Coustenis[4], *[1]Laboratoire AIM, Université Paris Diderot – Paris 7/CNRS/CEA-Saclay, DSM/IRFU/SAp, 91191 Gif sur Yvette, France (sebastien.rodriguez@cea.fr), [2]Laboratoire de Planétologie et Géodynamique, CNRS-UMR 6112, Université de Nantes, 2 rue de la Houssinière, 44322 Nantes, France ; [3]Department of Physics, University of Idaho, Engineering-Physics Building, Moscow, ID 83844, USA ; [4]LESIA, Observatoire de Paris, section de Meudon, 5 place Jules Janssen, 92195 Meudon Cedex, France ; [5]Groupe de Spectroscopie Moléculaire et Atmosphérique, UMR CNRS 6089, Université de Reims, U.F.R. Sciences Exactes et Naturelles, Moulin de la Housse B.P. 1039, 51687 Reims Cedex 2, France ; [6]Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Dr., Pasadena, CA 91109, USA ; [7]Department of Planetary Sciences, University of Arizona, Lunar and Planetary Laboratory, 1629 E. University Blvd., Tucson, AZ 85721, USA ; [8]Institut de Physique du Globe de Paris, Laboratoire de Dynamique des Fluides Geologiques, Paris, France ; [9]Laboratoire Matière et Systèmes Complexes, Université Paris Diderot, Paris, France ; [10]Laboratoire Atmosphères, Milieux, Observations Spatiales (LATMOS-UVSQ), Paris, France ; [11]DLR, Institute of Planetary Research, Rutherfordstrasse 2, D-12489, Berlin, Germany ; [12]United States Geological Survey, Mail Stop 964, Box 25046, Denver Federal Center, Denver, CO 80225, USA ; [13]Space Science and Engineering Center, University of Wisconsin-Madison 1225 West Dayton St., Madison, Wisconsin 53706, USA ; [14]Department of Astronomy, Cornell University, 418 Space Sciences Building, Ithaca, NY 14853, USA.*

Introduction: Titan, the largest satellite of Saturn, is the only satellite in the solar system with a dense atmosphere. The close and continuous observations of Titan by the Cassini spacecraft, in orbit around Saturn since July 2004, bring us evidences that Titan troposphere and low stratosphere experience an exotic, but complete meteorological cycle similar to the Earth hydrological cycle, with hydrocarbons evaporation, condensation in clouds, and rainfall. Cassini monitoring campaigns also demonstrate that Titan's cloud coverage and climate vary with latitude. Titan's tropics, with globally weak meteorological activity and widespread dune fields, seem to be slightly more arid than the poles, where extensive and numerous liquid reservoirs and sustained cloud activity were discovered.

Only a few tropospheric clouds have been observed at Titan's tropics during the southern summer [1-4]. As equinox was approaching (in August 2009), they occurred more frequently and appeared to grow in strength and size [5-7].

VIMS observations: We present here the observation of intense brightening at Titan's tropics, very close to the equinox. These detections were conducted with the Visual and Infrared Mapping Spectrometer [8] (VIMS) onboard Cassini. Figure 1 presents the VIMS color composite images of the three individual events detected so far, observed during the Titan's flybys T56 (22 May 2009), T65 (13 January 2010) and T70 (21 June 2010). T56, T65 and T70 observations show an intense and transient brightening of large regions very close to the equator, right over the extensive dune fields of Senkyo, Belet and Sangria-La. They all appear spectrally and morphologically different from all transient surface features or atmospheric phenomena previously reported. Indeed, these events share in particular a strong brightening at wavelengths greater than 2 µm (especially at 5 µm), making them spectrally distinct from the small tropical clouds observed before the equinox [1,3,7] and the large storms observed near the equator in September and October 2010 [6].

Discussion: In this paper, we will discuss the possibility that these singular events may have occurred very close to the surface, having a strong link with the underlying dune fields. Radiative transfer calculations indeed show that these singular brightenings are due to the transient appearance of an additional atmospheric layer, confined at very low altitudes and loaded with few but large particles. Gathering all the observational and modeling constraints, we conclude that the most probable explanation for these events is the local and transient occurrence of huge dust storms, directly originating from the underlying dune fields. We will also discuss the possible implications of the equinoctial occurrence of such events for Titan's tropical wind regimes and for the present-day activity of equatorial dunes.

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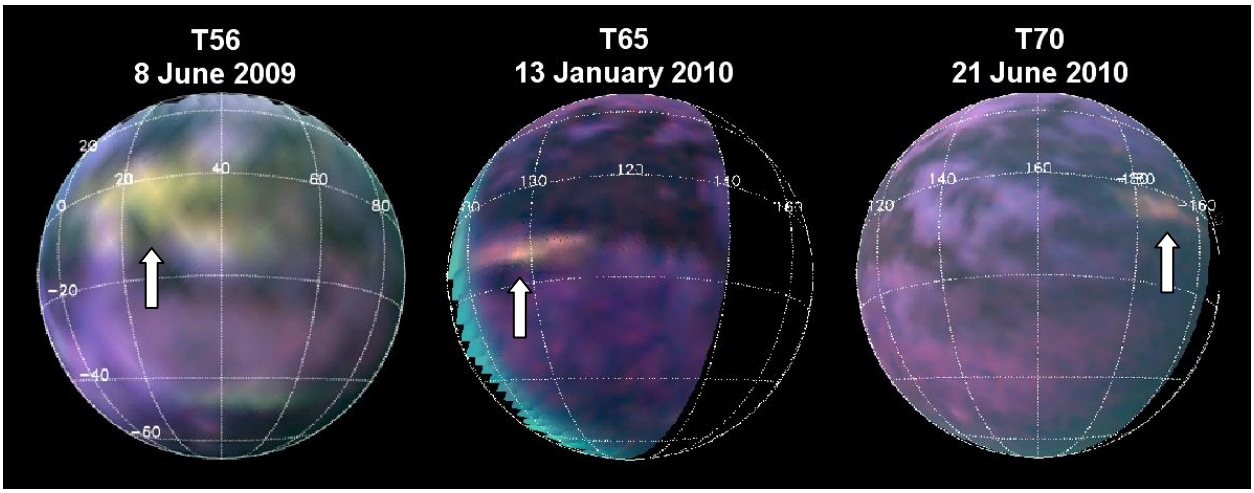

Figure 1. Orthographic reprojection of VIMS observations of Titan during the T56, T65 and T70 flybys. These images are RGB color composites, using the VIMS 5 μm channel as red, the 2.78 μm as green and 2 μm as blue. The yellowish/pinkish areas, also marked by the white arrows, denote the unusual spectral behaviour of large regions within Titan's tropics, very close to the equinox.